

# MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE. Assistant Editor: FRANK OWEN STETSON.

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The MONTHLY WEATHER REVIEW is based on data from about 3500 land stations and many ocean reports from vessels taking the international simultaneous observation at Greenwich noon.

Special acknowledgment is made of the data furnished by the kindness of cooperative observers, and by R. F. Stupart, Esq., Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt I. S. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Director Mete-

orological Office, London; H. H. Cousins, Chemist, in charge of the Jamaica Weather Office; Rev. L. Gangoiti, Director of the Meteorological Observatory of Belen College, Havana, Cuba.

As far as practicable the time of the seventy-fifth meridian is used in the text of the MONTHLY WEATHER REVIEW.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea level and latitude 45°.

## FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

### AN UNSEASONABLE WARM PERIOD IN THE UNITED STATES.

The temperature of the third decade of March averaged 12° to 21° above the normal generally east of the Rocky Mountains. In the Eastern States this remarkable and probably unprecedented 10-day period of March heat was due to the passage of two well-marked warm waves that advanced from the Great Plains to the Atlantic coast. These warm waves had their origin in a heated area that set in over the Middle-western and Southwestern States from the 16th to the 18th, and continued in that region for about ten days, with maximum temperatures of 90° to 100° in Oklahoma and Kansas. The first offshoot from this heated area advanced over the Mississippi Valley on the 21st and reached the Atlantic coast on the 22d, attended at many points by the highest temperatures on record for March. At Washington, D. C., 90°, or higher, was reached on three days, the highest, 93°, being registered on the 23d. This was 10° above the highest March temperature previously recorded for Washington. The second warm wave of this decade advanced from the eastern Rocky Mountain slope to the Atlantic coast from the 24th to 29th, with temperatures at many points that exceeded those of any previous March. On the 29th the heated area in the Middle West and Southwest was dissipated by an area of high barometer from the Pacific. This high area was attended by a cold wave that carried the frost line to northern Florida by April 1.

The associated apparent causes of periods of unusual weather are found in the abnormal distribution of barometric pressure over and near the regions affected. In the case of the March warm period the barometer was continuously low or falling over the western half of the United States from the 18th to 28th. Attending the eastward advance of the warm wave on the 21st and 22d, pressure was low over the entire country except the extreme southeast. On the 24th the warm period in the Eastern States was temporarily broken by a high barometer area that moved from the Hudson Bay region over the Atlantic States from the 24th to 27th. In the meantime barometric pressure had remained low in the West. Following the southeast passage of the Hudson Bay high area southerly winds with rapidly rising temperature again set in over the eastern districts, and continued until broken by the cold wave of the 30th. A consideration of the greater areas of barometric pressure shows that during this warm period pressure was exceptionally high for the season over the interior of Asia, and corre-

spondingly low over the north Pacific Ocean. The effect of continued low pressure over the northern Pacific is shown in the low pressures that continued over central and western portions of the American Continent, which were in turn responsible for the prevalence of warm southerly winds over the eastern half of the United States during the latter half of the month.

Aside from the warm period referred to, average winter temperatures prevailed over the eastern half of the country. In Maine and the Pacific States the month was colder than usual, and over the northern half of California the deficiency was 3° to 6°.

### IN GENERAL.

No specially notable features were shown by European and central Asiatic reports. There were two interruptions of the high barometric pressure that prevails at this season over the interior of Asia, one in the first decade and the other at the close of the month. In each case there appeared to have been a slow eastward drift of low barometric pressure from west-central and northwestern Europe, and from the Iceland low area, where, at Seydisfjord, readings below 29.00 inches were recorded during brief periods in each decade. British Isles pressures were generally high, except from the 15th to 19th and at the close of the month, when disturbances of marked intensity crost that region. In the vicinity of the Azores the barometer was exceptionally high during the first half of the month, and readings did not fall below 30.00 inches until the 31st. Over the western Atlantic storms advanced from the northern coasts on the 2d to 4th, 6th, 20th, and 23d, the storm of the 20th being particularly severe on the New England and Canadian coasts. The passage from the continent of storms of moderate strength caused low barometric pressure at Bermuda on the 6th, 25th, and 26th. A feature of the closing days of March was a storm off the extreme southeast coasts of the United States. As this storm acquired its greatest intensity early in April, its description will appear in the MONTHLY WEATHER REVIEW for that month.

A number of disturbances of moderate energy crost the Great Lakes, one in the first and third decades and four in the second decade of the month. On the Pacific coast barometric pressure was generally low, more especially during the second and the first half of the third decades, the lowest reading, about 29.15 inches, being noted on the north Washington coast on the 23d.

Precipitation was in excess in the Rocky Mountain and Plateau districts and thence over California and southern Oregon. In California the month was one of the wettest Marches on record.

Heavy rains in the second decade of the month caused exceptionally high stages in the Ohio River and tributaries. At Pittsburg, Pa., a stage of 35.5 feet was reached on the morning of the 15th. This is the highest stage of water ever recorded at Pittsburg, and exceeded the record stage of February 10, 1832, by 0.5 foot. The water at Pittsburg receded rapidly after the 15th, until the 19th, when another rainstorm caused a rise to 24.4 feet, 2.4 feet above the flood stage, at 5 p. m. on the 20th. Heavy rains that set in on the Pacific coast on the 16th and continued several days, combined with melting snow in the mountains, caused destructive floods in the Sacramento Valley, Cal.

The night of the 5th a heavy snowstorm, attended by high wind, thunder and lightning, visited the Middle Atlantic States. On the 10th a heavy snowstorm covered the Middle Atlantic and New England States and the Canadian Maritime Provinces.

#### BOSTON FORECAST DISTRICT.

Storms of notable severity occurred on the 11th, 19th, and 20th. On the 19th heavy snow fell in northern New England, and on the 20th the wind attained velocities on the coast of 35 to 77 miles an hour. Storm warnings were timely, and there was no damage and little delay to shipping.—*J. W. Smith, District Forecaster.*

#### NEW ORLEANS FORECAST DISTRICT.

Frost warnings were issued on two days and frost occurred in the section covered by the warnings. Frost occurred over limited areas, without warnings, on two days. Cold-wave warnings were not issued or required, and no general storm occurred on the Gulf coast.—*I. M. Cline, District Forecaster.*

#### LOUISVILLE FORECAST DISTRICT.

After the 13th exceptionally warm weather prevailed, and day after day March temperature records were broken. The month closed with a cold wave and killing frost, regarding which due warnings were issued. The flood in the Ohio River caused widespread damage, altho in this vicinity damage was not so great as from the January flood.—*F. J. Walz, District Forecaster.*

#### CHICAGO FORECAST DISTRICT.

The special features of the month were extremely high temperatures over practically the entire district, with no cold waves of consequence. Advisory messages were sent to open ports on Lake Michigan previous to the occurrence of storms, and no damage by storms is known to have occurred.—*H. J. Cox, Professor and District Forecaster.*

#### DENVER FORECAST DISTRICT.

March was wet west of the Continental Divide and dry on the eastern slope, with an excess of temperature thruout the district. In eastern Colorado the month was the mildest March on record. No cold-wave warnings were issued.—*F. H. Brandenburg, District Forecaster.*

#### SAN FRANCISCO FORECAST DISTRICT.

Unusually heavy precipitation caused destructive floods in central and northern portions of California. Storm warnings were necessary on a number of dates. There were some frosts, but fewer than usual.—*A. G. McAdie, Professor and District Forecaster.*

#### PORTLAND, OREG., FORECAST DISTRICT.

The month was not as stormy as usual. During a storm on the 22-23d maximum velocities of 74 miles at North Head, Wash., and 60 miles at Tatoosh Island were reported. No marine casualties were reported in connection with the storms of the month. Timely warnings were issued for all damaging frosts.—*E. A. Beals, District Forecaster.*

## RIVERS AND FLOODS.

For the second time within the short period of two months the Ohio Valley was visited by a great flood. The flood waters from the great rise of January had scarcely past into the Mississippi before the rains that were to cause another began over the headwaters. The two floods differed materially in character in that above the mouth of the Great Kanawha River that of January was very moderate, while that of March was decidedly the reverse, so much so in fact that stages beyond all previous records were reached at Pittsburg and along the Youghiogheny River generally. The apparent antecedent conditions of the two floods were not greatly dissimilar, except that over the watershed of the Conemaugh and Kiskiminetas, the lower Youghiogheny, and the upper Allegheny rivers there were from 4 to 8 inches of moist, heavy, and comparatively fresh-fallen snow on the ground on March 10 and 11, whereas immediately preceding the flood of January there was little or none. The amount of rainfall was somewhat greater during the January flood, but in March differences in distribution, combined with high temperatures and the rapid melting of the snow over the Allegheny, Kiskiminetas, and Youghiogheny watersheds, caused a volume of water that more than compensated for the deficiency in the amount of precipitation.

The greater portion of the heavy rains fell on two successive days, the 13th and 14th, just at the time when, under the influence of temperatures that were from 10° to 25° above normal conditions, all the snows over the Allegheny and Monongahela watersheds were melting with great rapidity and running into the streams.

From the mouth of the Great Kanawha to the mouth of the Scioto the crest stages of the two floods were very nearly alike, as were also the periods of duration. Below the mouth of the Scioto the crest stages of March were from 1 to nearly 5.5 feet below those of January, on account of the limited supply of water contributed by the southern tributaries, notably the Great Kanawha, the Big Sandy, and the Guyandotte. This deficiency in the precipitation over the State of West Virginia is probably all that prevented a flood of much greater proportions. The headwaters of all northern tributaries were above flood stages, and had the West Virginia tributaries, with the Big Sandy, contributed their usual proportionate share of water, the flood of February, 1884, might easily have been compelled to yield its precedence, at least below the mouth of the Great Kanawha River.

The damage caused by the flood was approximately as follows:

Pittsburg, Pa. ....	\$5,600,000
Parkersburg, W. Va. ....	200,000
Cincinnati, Ohio. ....	200,000
Louisville, Ky. ....	100,000
Interior Ohio. ....	1,500,000
Total. ....	\$7,600,000

To these figures must be added the expense of moving property beyond reach of the flood waters, as well as the losses occasioned by the interruption of business, so that the total damage must have amounted to at least \$8,000,000.

An inspection of the weather maps and special reports shows that the flood at Pittsburg can be attributed mainly to the enormous volumes of flood waters caused by the excessive rains and melting snows from March 12 to 14 over the Kiskiminetas and Youghiogheny watersheds. The Monongahela, of course, contributed largely, but not so much as in the January flood, when the stages above the mouth of the Youghiogheny were from 3 to 5 feet higher. Not nearly so much rain fell over the upper Allegheny, less than 1 inch in fact, and no water of consequence came from the region above the mouth of the Kiskiminetas until the afternoon and evening of